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AUTOMATED AERONAUTICAL MISSION PLANNING SYSTEMS: IMPLICATIONS FOR TRAINERS

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INTRODUCTION

To accomplish Department of Defense (DoD) missions, training must include all aspects of the mission, including mission planning. This planning can occur over different time scales depending on the amount of time available prior to the actual mission. Planning can involve any of the following: development of the *scenarios* expected to be followed; preparation and generation of *products*, such as the operations orders, maps and overlays, execution matrices, and administrative orders; *coordination* of all elements anticipated to be on the battlefield; *consideration* of available information from a variety of sources; *establishing parameters* for best meeting the challenges presented; and *preparing initialization data* both for the equipment to be used and the simulation battlefield, if applicable.

Planning and preparation for aviation missions require that essential mission information be input into the cockpit prior to mission start. This information may include route plans, communications data, waypoint designations, friendly and threat situations, and weather information. Planning in a simulation environment requires that system initialization data be input to include initial placement of friendly and opposing forces, battlefield and environmental conditions, and network communications.

All US Services now have available automated mission planning systems (MPSs) for aeronautical systems. Not only can these systems aid in mission planning speed, accuracy, and coordination, but also they can assist with creating total battlespace awareness, and have great potential for Joint Service planning and mission rehearsal training. Since use of automated MPTs is an essential part of today's missions, it is critical that trainers understand the capabilities offered by various automated MPSs so that they can develop training concepts and plans to best capitalize on the opportunities presented by these systems.

FINDINGS

Automated Mission Planning System Descriptions

AFMSS. AFMSS consolidated legacy mission planning systems to support Air Force (AF) and Special Operations planners by providing graphics tools, tactical decision aids, and threat envelope projections that operate on off-the-shelf components. To aid in mission execution, AFMSS also provides electronic *Combat Mission Folders*, consisting of maps, charts, flight logs, turn points, target imagery, weapons delivery calculations, and radar predictions. AFMSS also has the ability to select optimal routes through hostile environments. AFMSS is designed around a core of software programs and a number of plug-in, system-specific modules for avionics, weapons, and electronics modules. These modules include items specialized for each aircraft or group of aircraft served, such as *the Common Low Observable AutoRouter* route planner for low observable aircraft. AFMSS operates as either a stand-alone system, or linked with other command information systems, thus providing a significant benefit to command and control performance by enhancing information

superiority for the warfighter and by providing unique capabilities in support of both precision engagement and dominant maneuver *Joint Vision 2010* (DoD, 1996) goals (DOT&E, 1997). AFMSS comprises the following subsystems:

- Portable Flight Planning Software (PFPS) (PC-based),
- Mission Planning System (MPS) (UNIX-based)

AFMSS provides an integrated environment supporting all missions and aircraft. It helps crewmembers plan entire missions on one system—any mission, any aircraft, anywhere in the world. New aircraft or new missions can be easily added to the system without changing the basic planning tools such as electronic maps, route planning, threat analysis, terrain and target analysis, and mission preview. Intelligence, weather, weapon delivery parameters and operational data may be automatically fed into the AFMSS databases for use by the system. PFPS has interoperability with *Theater Battle Management Core Systems* to allow for *Air Tasking Order and Air Space Coordination Order*. Figure 1 shows an aircrew member using AFMSS.

SOFPARS. SOFPARS has been integrated within the latest version of AFMSS MPS software, making it a version of AFMSS with specialized modules to support data preparation and added mission planning for the AF Special Operations Command (AFSOC). Its numerous configurations are used to support specific requirements in the areas of special operation, night search and rescue, infiltration or airdrop, and can be used to support missions in any weather, at any time, or in any place in the world. Both SOFPARS and AFMSS can be integrated into ruggedized, shock mounted cases, for rapid setup and tear down for easy transport (Sanders, 1996a, b).

PFPS. PFPS was first designed independently of AFMSS by AF personnel and is currently government-owned and developed with annual revisions by the 46th Test Squadron Mission Planning Flight (TS/OGET) at Eglin AFB, FL. This software was recently adopted as the PC system of AFMSS; the two systems can exchange flight plans (routes) and point libraries. PFPS is capable of supporting all missions and aircraft by using tools including route and airdrop planning, tabular and digital mapping views, weapons delivery, target area tactics, and cartridge loading. Unlike the other major MPSs, PFPS uses a common, Microsoft Windows '95 graphic user-interface running on any commercially available desktop or portable PC computer system. The major system components are:

- Combat Flight Planning Software (CFPS)
- FalconView
- Combat Weapon Delivery Software (CWDS)
- Combat Airdrop Planning Software (CAPS)
- Cartridge Loader (selected aircraft)

According to the PFPS Program Office, the system supports threat depiction and detection/lethality depiction. FalconView is a government-owned mapping package, which displays various maps and geo-referenced overlays. Flight planning information from CFPS is displayed graphically by FalconView and allows route information input or changes using a 'point and click' method through Falcon View to be displayed textually in CFPS. FalconView uses multiple overlays (navaids, special-use airspace, threats, electronic chart update manual, and drawing tools) to aid in flight crew situational awareness (Georgia Tech Research Institute, 1997). Using a laptop connected to a GPS receiver, PFPS provides a moving map display, currently in use aboard AF One, search and rescue helicopters, and some ground vehicles (46th TS, 1998). PFPS was first designed by AF personnel, is currently government-owned and developed by the 46TS/OGET at Eglin AFB FL with annual revisions. The software is available for download from the 46th TS/OGET web page (46th TS, 1998). Currently used by all USAF aircraft except the B-2, it is also being fielded by the Navy and the United States Special Operations Command (USSOCOM). Training, in the form of on-line files and tutorials or periodic training sessions, is available through the 46th TS' Testing Team at Eglin AFB, FL. Classes are hosted at Eglin and TDY locations, as well as presented on-line and CD-ROM (46th TS, 1998).

TAMPS. TAMPS supports US Navy (USN) and Marine Corps (USMC) with a computerized method of planning and optimizing aeronautical mission routes against hostile targets using a common automated system for rapidly processing large quantities of digitized terrain, threat and environmental data, aircraft, avionics, and weapon systems parameters. It is intended to meet the tactical naval mission planning and digital data upload requirements of fixed and rotary wing aircraft standoff weapons, avionics systems, mission support systems, and Unmanned Air Vehicles (UAVs). It provides users near-real-time updates to weather and intelligence databases, maintaining consistent displays and user interactions across all platforms, helping these forces to meet the Joint Vision 2000 (DoD, 1996) goals of information superiority and dominant maneuver. TAMPS core software interfaces with a wide variety of USN and USMC Command, Control, Communications, Computers, and Intelligence systems. Platform-unique requirements are provided via a Mission Planning Module (MPM) system that integrates with appropriate core libraries and servers providing a complete planning environment for any user platform and produces products including digital loads, strip route charts, and pilot kneeboard cards (TAMPS OAG, 1998). In addition to TAMPS, the Navy is using PFPS as an interim PC-based system until JMPS is available.

TPS / TMPC. Known as either the TPS or TMPC, this system is used to plan and prepare mission data for both nuclear and conventional TOMAHAWK Land Attack Missile (TLAM) missions. The TPS/TMPC consists of four subsystems: TLAM Planning System (TPS), Digital Imagery Workstation Suite (DIWS), the Mission Distribution System (MDS), and the Precision Targeting Workstation (PTW). The DIWS provides maps and precision target location measurements, and the MDS receives mission data and supporting information from TPS and transcribes mission data for distribution. The PTW, which performs tasking analysis, supports streamlined planning of precision strike and robust mission planning in the presence of atmospheric and meteorological variations (Kobee, 1996 and DOT&E, 1997).

AMPS. AMPS is a subordinate system of the Army Battle Command System, Maneuver Control System (MCS). AMPS is a computer and graphic user interface software based tool that automates Army aviator mission planning tasks to provide pilot assistance in improving battlefield synchronization and intelligence in the area of tactical command and control. Integration of information with an aviation Tactical Operations Center (AVTOC) provides systems with the ability to access, use and share critical mission related data. Software is hosted on a portable ruggedized workstation, Lightweight Computer Unit, under the Army Common Hardware/Software contract, with peripheral devices such as the data transfer system, printer, optical drive, and CD-ROM drive. AMPS automates battalion and company planning, and distribution of mission files between units. It provides mission data in hard copy or electronic formats for loading into the aircraft for navigation, communications, weapons, and post-mission information (AMPS, TAEC, 1997).

Interoperability

Because so much of today's mission planning requires close coordination between and within the Service components and the joint staff, it was essential to prescribe common interface protocols and operating environments. The Defense Information Systems Agency (DISA) developed a series of the DoD Technical Architecture for Information Management (TAFIM) guidelines and standards called the DIICOE. The GCCS is being developed using these standards. COMPASS is the initial method of helping legacy MPSs communicate effectively with each other (see description below).

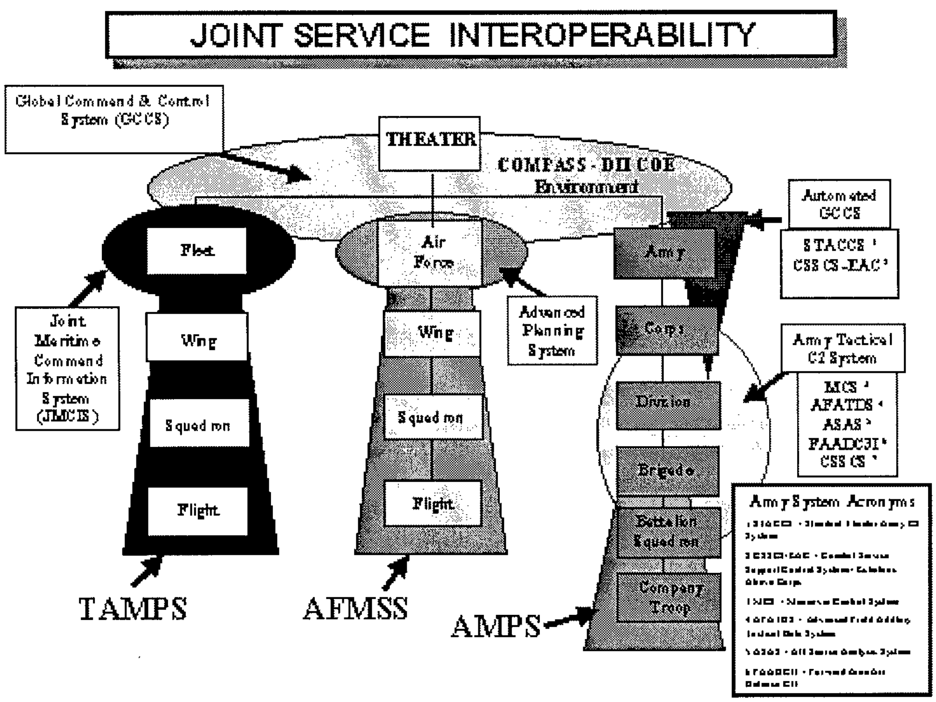
GCCS. The GCCS is being built to replace the older text-base World Wide Military Command and Control Systems (WWMCCS) using the DII COE architecture. GCCS provides commanders a single source for sending and receiving information required for collaborative mission planning and execution (AF News, 1997 and Proctor, 1995).

DII COE. The DII COE is a collection of reusable software components, a software infrastructure for supporting mission-area applications, guidelines, standards, and specifications. DII COE is an architecture fully compliant with the TAFIM. The DII COE is mission application independent. (DISA, 1998).

COMPASS. COMPASS is an advanced technology demonstration project sponsored by the Defense Modeling and Simulation Office (DMSO) and Defense Advanced Research Projects Agency (DARPA). COMPASS is

being fielded as part of the evolving DII COE by the Joint Warrior Interoperability Demonstration (JWID) Joint Program Office as an approach to interoperable, distributed collaborative planning that allows planners to use their legacy systems to move seamlessly between planning, analysis, and mission rehearsal modes. Its purpose is to promote and support the integration and interoperability of existing systems that are not DII COE compliant. COMPASS' functionality begins at the external boundaries of today's legacy planning systems and imposes minimal interface requirements. It comprises a Mapping, Charting, Geodesy, and Imagery (MCG&I) database, a basic navigation planning capability, and uses Transmission Control Protocol/Internet Protocol (TCP/IP) networking protocols to ensure compatibility across existing systems. It provides the following set of open systems-compliant modeling and simulation and Distributed Collaborative Planning (DCP) services, such as DCP session management, shared map overlay exchange, and composite route preview. Today, COMPASS uses "middleware" consisting of well-defined interfaces, such as groupware and the Distributed Interactive Simulation (DIS) protocols to allow for composite mission preview. Future releases may use the High Level Architecture (HLA) interface standards. COMPASS allows for distributed collaborative planning development, preview, and revision capabilities not otherwise currently available to DII COE and legacy systems. The relationship between the service MPSs, command and control systems, and the GCCS facilitated by COMPASS and DII COE are illustrated in Figure 2.

JMPS. JMPS is a joint Navy-AF development effort to evolve their MPSs (TAMPS and AFMSS) into the GCCS using the DII COE. PFPS may be used as the basis for this new system. JMPS will be a family of systems comprising components hosted on a common framework, which will then be hosted as a segment on the DII COE. JMPS will eventually replace the current versions of AFMSS and TAMPS. The Army is considering involvement in JMPS. Plans are for GCCS to use PowerScene© for visualization (TAMPS OAG, 1998). Ultimately, JMPS could improve common training methods across Service lines.



Human Interface Issues and Goals

Initial Interface Problems. Initial operational test and evaluations found both TAMPS and AFMSS lacking in their human interface. AFMSS had a "very poor user interface, and the lack of operator feedback and warnings

contributed to delays and an increase in workload. Printed charts were unacceptable because of poor resolution, particularly for low-altitude tactical flight use." System stability and human-machine interface were considered so serious that the TAMPS version 6.0.5 (in 1996) was not ready for operational test. Thus human interface concerns are an essential part of both improvements and new evaluations. (DOT&E Annual Report, 1997). Both systems have attempted to overcome these problems. These interface problems, of course, make the trainer's job more challenging.

Human Interface Goals. Highlights of these goals include the following: the system should be sufficiently *responsive* and *user-friendly* to make real-time decisions in support of mission execution, which much be accurate, timely, and usable. The MPS should permit pilots and planners to construct, coordinate, and deconflict their plans faster than in the manual mode. When users set time goals based on the complexity of the mission, MPSs should be sufficiently flexible to allow for last-minute changes without having to reenter or start from scratch. Connection with visual fly-throughs should be interactive so that changes made in the visual mode may be automatically reentered as a change to the mission plan. If the MPS is to be a practical decision aid, it must be accurate; therefore, goals to display threats, intercepts, terrain, and route conflicts, are essential to mission success—the overall measure of effectiveness. Short any of these goals and trainers will have to "train around" system problems.

Training Opportunities and Challenges

Data links with mission rehearsal systems. Most automated MPSs have the capability to transfer route and threat data to simulators using Distributed Interactive Simulation or HLA protocols. While it has been a challenge, these protocols and the COMPASS system are solving interface problems.

Mission fly-through or rehearsal. With the worldwide digital map, realistic fly-throughs are possible anywhere. Fly-throughs prior to mission enable *real* mission rehearsal just prior to the actual mission.

3D Viewer Integration. The integration of a 3D simulation viewer, such as PowerScene (Cambridge, 1998), TOPSCENE (USA Corps of Engineers, 1998), Falcon View (GTRI, 1997), Wings (USA Corps of Engineers, 1998), or DrawLand (USA Corps of Engineers, 1998), with AFMSS and TAMPS have reinvented how missions are planned. After designing their mission in the mission planning system, crew members export route, threat analysis data, and other valuable mission data to the 3D viewer, where they experience the mission in photo-realistic 3D and receive the vital visual feedback that would have been otherwise unavailable to them. Alterations to the mission plan can be made in PowerScene; the data is then exported back to the mission planning system for instant reverification and recording. The challenge is to make this transfer of files effortless and seamless.

Distributed Collaborative Planning. The Service MPSs within the COMPASS and DII COE operating environment offer great opportunity for distributed collaborative planning tools. The analysis, preview, rehearsal, and plan debugging can improve planning judgements and help identify and resolve plan conflicts and disconnects. Post action analysis of plans and mission modeling can also assist by making future mission planning more comprehensive and coordinated.

After Action Review (AAR) Improvements. With mission waypoints readily available, AARs can now review the mission in 3D with stop action, instant replays, etc. Changes in threats that occurred after takeoff can be inserted to see what took place and why, all improving lessons learned during AARs.

Other opportunities and challenges. A great challenge is refining the interface to enable rapid planning. Duplicating and adjusting prior mission plans have some advantages, but could result in failure to fully plan the mission. Automation often has its price in human error, such as the programming error on the shotdown Korean Airliner that was off track due to automated duplication errors. Complacency could expose aircrews to dangerous situations by making flights too routine, predictable, or by omitting important planning steps. The challenge is to keep planners alert while speeding planning.

Training Flourishes

Joint Exercise Training and Experience to New Level. A most exciting training flourish is the way COMPASS, using legacy systems, can facilitate the training of joint planners for exercises. For the first time, members of each Service will be able to see the simulated impact of their plans on other Services. Learning from this new mode is sure to educate a new class of Joint military planner, enabling closer cooperation and battlespace coordination, saving time, money, and eventually lives.

Individual Planning Feedback. By linking mission plans directly with simulated fly-throughs prior to taking off, the planners can see the results of their efforts. Now aircrews can play "what-if's" ahead of real mission, improving and debugging plans, as well as rehearsing the plans to top proficiency. The new frontier in training will be how to make these just-in-time fly-throughs an educational experiences as well as preparation for the next flight.

Promise of MPSs. Prompt, specific feedback has always promoted efficient learning. Now trainers can see the advantages of learning as aircrews and planners plan and coordinate their mission, rather than having to wait for after-battle videotape analysis. By using automated integrated MPSs, the aircrew can be experienced with the specific mission several times over before any risk is incurred. Once the mission is over, the MPS integrated with a 3D viewer can clearly illustrate lessons learned and "what-if" alternatives during after action reviews.

CONCLUSIONS

Automated MPSs offer so many features and promote automated communication to improve battlespace awareness that they will be a definite part of the future training development landscape. Human factors in MPSs still need significant improvements to enable the speed and user friendliness needed for full acceptance. Meanwhile, training developers need to incorporate MPSs in their scenarios and plan how to best conduct pre-mission fly-throughs, while human factors engineers continue to improve the human interface.

REFERENCES

Air Force News. (1997). *Global command-and-control system fully in place.* Available: http://www.af.mil:80/search/

Aviation Mission Planning System (AMPS) Team, Aviation Electronic Combat. (1997). *Aviation Mission Planning System (AMPS) System/Subsystem Specification, Appendix A, Detailed Software Requirements.* St. Louis, Missouri: Author.

Cambridge Research Associates, Inc. (1998). *PowerScene©*. [Online] Available: http://www.cambridge.com/contact.html

Defense Information Systems Agency (DISA). (1998). *Defense Information Infrastructure (DII) Common Operation Environment (COE) Configuration Management Plan*, Version 2.0. Washington, D.C.: DoD DISA Joint Interoperability and Engineering Organization.

Defense Operational Test & Evaluation (DOT&E). (1997), DOT&E FY97 DOT&E Annual Report. [Online]. Available: http://www.dote.osd.mil/reports/FY97/97tocmain.html

Georgia Tech Research Institute (GTRI). (1997). *Falcon View Soars* [Online]. Available: http://www.gtri.gatech.edu/rh-sf97/falcon.htm .

Kobee, Robert M. (1996). *Unmanned Aerial Vehicle (UAV) Mission Planning Requirements Study. Appendix C: Mission Planning Systems Analysis.* MITRE Report W097-L-124, McLean, VA: Navy Combat Systems (NCS) C3 Engineering.

Office of the Director, Operational Test & Evaluation (DOT&E), Department of Defense. (1996). *Tactical Aircraft Mission Planning System (TAMPS)* [Online]. Available:

http://www.dote.osd.mil/reports/FY96/96TAMPS.html

Proctor, Annie E (1995), ALCOM uses new command, control system, *Air Force News*, Available: http://www.af.mil:80/search/

Sanders (Lockheed Martin Company). (1996a). *Air Force Mission Support System (AFMSS)* [Online]. Available: http://www.sanders.com/mission_support/afmss.html

Sanders (Lockheed Martin Company). (1996b). *Special Operations Forces Planning and Rehearsal System (SOFPARS)* [Online]. Available: http://www.sanders.com/mission_support/sofpars.html

Science Applications International Corporation (SAIC). (1998). *COMPASS Overview* [Online]. Available: http://compass.saic.com/ver1/overview.htm

TAMPS Operational Advisory Group (1998), *Briefings and Minutes* [Online]. Available: http://copernicus.hq.navy,mil/n6/n62/tamps/oag/index.html

US Army Aviation Battle Laboratory (ABL) Support Team. (1996). *Army Aviation Mission Planning System User Functional Description.* Ft. Rucker, AL: Author.

US Army Corps of Engineers. (1997). *Survey of Terrain Visualization Software Product Information* [Online]. Available: http://www.tec.army.mil/TD/tvd/survey

46th Test Squadron (TS) Mission Planning Flight (46TS/OGET). (1998), *Portable Flight Planning Software (PFPS)* [Online] Available: http://www.mission-planning.eglin.af.mil/pfps.htm

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